

REMARKS

New claims 17 and 18 have been added. Claims 1-18 are pending in the present application.

The applicant affirms the election of claims 1-15 and new claims 17 and 18, which are dependent on claim 1.

The Examiner rejected claim 2 under 35 U.S.C. § 112, as containing subject matter which is not described in the specification in such a way as to enable one skilled in the art to which it pertains, or which it is most nearly connected to make and/or use the invention. The Examiner stated that the specification fails to show how a method for etching a metal-containing layer would be electrostatically attracting the plasma from the etchant gas to the substrate in the etch chamber; and electrostatically attracting the plasma from the etch mask stripping gas to the substrate in the etch chamber.

Page 6, lines 24 to 28, of the present application states, "A bias voltage is applied to a chuck that supports the substrate placing a potential across the wafer, thus electrostatically attracting plasma created from the etchant gas to the wafer (step 410). In the preferred embodiment the bias voltage is between -10 and -1,000 volts. More preferably the bias voltage is between -25 and -600 volts. Most preferably the bias voltage is between -50 and -400 volts." This passage makes known to one of ordinary skill in the art a step of how to perform a step of electrostatically attracting the plasma from the etchant gas to the substrate in the etch chamber. Page 8, lines 9 to 11, of the present application further states that "A bias voltage is applied to a chuck that supports the substrate, thus electrostatically attracting the plasma created from the stripping gas to the wafer (step 422)." This passage further describes voltage and power ranges that are preferably used to achieve this result. Therefore this passage makes known to one of ordinary skill in the art how to perform a step of electrostatically attracting the plasma from the etchant gas to the substrate in the etch chamber. For these reasons, claim 2 does not contain subject matter which is not described in the specification.

The Examiner rejected claims 1, 3, 4, 5, and 15 under 35 U.S.C. § 102 as being anticipated by Hsieh et al. (US 5,776,832). The technology discussed in Hsieh used polymers for sidewall passivation. Such sidewall polymers may be removed using an oxygen ashing. Currently, the minimum interconnection critical dimensions are too small to use a thick resist

that uses polymer sidewall passivation. As a result, it is desirable to use redeposited metal for sidewall passivation.

Hsieh does not teach the step of stripping away the etch mask and removing some residual sidewall passivation, while the substrate is in the etch chamber, as recited in claims 1 and 15. The Examiner stated that it is noted that a photoresist is removed by conventional resist stripping techniques such as by O₂ ashing, and that hence Hsieh's O₂ ashing step is the same as the applicant's stripping step. The oxygen based ashing described in Hsieh to remove polymer sidewalls would not be successful in removing inorganic sidewalls, since Hsieh does not use a bias voltage during ashing. Metal sidewall polymer is a polymer deposited on the sidewall of the metal layer it is not redeposited metal. The residual sidewall passivation recited in claims 1 and 15 is formed from redeposited parts of the metal containing layer and therefore is made of an inorganic material. The ashing step in Hsieh is only for removing photoresist polymer, not for removing inorganic metal redeposited to form sidewall passivation, as recited in claim 1 and 15. Nothing in Hsieh discloses removing some of the inorganic metal redeposited to form sidewalls during the stripping step.

For these reasons, Hsieh does not teach a step of stripping away the etch mask and removing some residual sidewall passivation, as recited in claims 1 and 15. For these reasons, claims 1 and 15 are not anticipated by Hsieh.

Claim 3 is dependent on claim 2 and for this reason is not anticipated by Hsieh.

Claim 4 is dependent on claim 3 and further recites that the step of stripping away the etch mask and removing residual sidewall passivation further removes residue from walls of the etch chamber. The Examiner did not cite anything in Hsieh that teaches removing residues from walls of the etch chamber. For these reasons, claim 4 is not anticipated by Hsieh.

Claims 5 is dependent on claim 4 and for this reason is not anticipated by Hsieh.

The Examiner rejected claims 2, 6, 7, 8, 9, 10, 11, 13, and 14 under 35 U.S.C. § 103 as being unpatentable over Hsieh as applied to claim 1 above, and further in view of Fukuyama et al. and Tepman et al.

Regarding claim 2, the Examiner states that Hsieh differs in failing to teach electrostatically attracting the plasma for the etchant gas to the substrate in the etch chamber, as

recited in claim 2. Column 5, lines 23-26, of Hsieh states that during etching a -260 volt DC bias is placed on the electrode on which the substrate is placed. As a result, the plasma for the etchant gas is electrostatically attracted to the substrate, as recited in claim 2. However, Hsieh in column 5, lines 49-52, specifically teaches that during O₂ ashing a zero DC bias is applied to the substrate. Table I of Hsieh also shows this. As a result, Hsieh does not teach electrostatically attracting plasma from the etch mask stripping gas to the substrate in the etch chamber, as recited in claim 2, but instead teaches away. The material to be removed by O₂ ashing in Hsieh is a polymer and not redeposited metal forming a residual sidewall passivation as claimed. As a result, a bias is not needed for Hsieh. Nothing in Hsieh suggests that a bias would be successful in removing residual sidewall passivation of redeposited metal material. The Examiner did not state how Fukuyama or Tepman would add to Hsieh to make obvious electrostatically attracting the plasma from the etch mask stripping gas to the substrate in the etch chamber. For these reasons, claim 2 is not made obvious by Hsieh in view of Fukuyama and Tepman.

Claims 6, 7, and 8 are ultimately dependent on claim 5, and for this reason are not made obvious by Hsieh in view of Fukuyama and Tepman.

Claims 9 and 12 are dependent on claims 8 and 4 respectively, and they further recite that the pressure during etching and stripping is maintained between 1 and 80 millitorr. Hsieh teaches in Table 1 that Step 1 and Step 2, which are etching steps, are performed at a pressure of 25 and 30 millitorres, respectively, and that Step 3, which is an O₂ ashing step, is performed at 150 millitorres. Therefore Hsieh teaches raising the pressure from the etching step to the ashing step, which teaches away from maintaining the pressure between 1 and 80 millitorr for both etching and ashing as recited in claims 9 and 12. For these reasons claims 9 and 12 are not made obvious by Hsieh in view of Fukuyama and Tepman.

Claim 10 is dependent on claim 9, and for this reason is not made obvious by Hsieh in view of Fukuyama and Tepman.

Claims 11 and 14 are dependent on claims 10 and 13 respectively, and they further recite a bias power between -10 and -1,000 volts for attracting plasma from the etchant gas and a bias power of between -10 and -1,000 volts for attracting plasma from the etch plasma stripping gas. Hsieh teaches in Table 1 that Step 1 and Step 2, which are etching steps, are performed with a DC bias of -260 volts and -220 volts respectively, and that Step 3, which is an O₂ ashing step, is performed a bias of 0 volts. Therefore Hsieh teaches reducing the bias voltage to zero from the

etching step to the ashing step, which teaches away from maintaining a bias voltage between -10 volts and -1,000 for both etching and ashing as recited in claims 11 and 14. New and unexpected results are produced by this biasing voltage during stripping. The new result is the ability to strip inorganic sidewall passivation made from redeposited metal, wherein previously only polymer was stripped. The unexpected success comes, because previously, it was believed that such a bias would sputter the metal layer damaging the metal lines. Such biasing may be performed to remove inorganic sidewall passivation, without damaging the metal lines. For these reasons claims 11 and 14 are not made obvious by Hsieh in view of Fukuyama and Tepman.

The Examiner failed to provide a specific explanation of how claims 13 and 14 are made obvious by the cited art.

Applicant believes that all pending claims are allowable and respectfully requests a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

If any fees are due in connection with the filing of this Amendment, the commissioner is authorized to deduct such fees from the undersigned's Deposit Account No. 50-0388 (Order No. 09/472,757). A duplicate copy of the transmittal sheet for this amendment is enclosed for this purpose.

Respectfully submitted,

BEYER WEAVER & THOMAS, LLP

A handwritten signature in black ink, appearing to read "Michael Lee", with a stylized flourish at the end.

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CLEAN VERSION OF PENDING CLAIMS

1. A method for etching at least partially through a metal-containing layer disposed above a substrate, wherein part of said metal-containing layer is disposed below an etch mask and part of said metal-containing layer is not disposed below the etch mask, comprising the steps of:

placing the substrate in an etch chamber;

flowing an etchant gas into the etch chamber;

creating a plasma from the etchant gas in the etch chamber;

etching away parts of the metal-containing layer not disposed below the etch mask, wherein some of the etched away parts of the metal-containing layer is redeposited to form residual sidewall passivation while the substrate is in the etch chamber;

discontinuing the flow of the etchant gas into the etch chamber;

flowing an etch mask stripping gas into the etch chamber;

creating a plasma from the etch mask stripping gas in the etch chamber;

stripping away the etch mask and removing some residual sidewall passivation, while the substrate is in the etch chamber; and

removing the substrate from the etch chamber.

2. The method, as recited in claim 1, further comprising the steps of:

electrostatically attracting the plasma from the etchant gas to the substrate in the etch chamber; and

electrostatically attracting the plasma from the etch mask stripping gas to the substrate in the etch chamber.

3. The method, as recited in claim 2, wherein the etch chamber is a metal etch chamber.

4. The method, as recited in claim 3, wherein the step of stripping away the etch mask and removing residual sidewall passivation further removes residue from walls of the etch chamber.

5. The method, as recited in claim 4, wherein the etch mask stripping gas comprises oxygen.

6. The method, as recited in claim 5, further comprising the steps of:

placing the substrate in a load lock; and

removing the substrate from the load lock to place the substrate into the etch chamber.

7. The method, as recited in claim 6, further comprising the steps of:

placing the substrate into a corrosion passivation chamber after the substrate has been removed from the etch chamber; and

exposing the wafer to a non-plasma high temperature water vapor.

8. The method, as recited in claim 7, further comprising the steps of:

transferring the substrate from the corrosion passivation chamber to a cooling station;

cooling the substrate in the cooling station; and

transferring the substrate from the cooling station to the load lock.

9. The method, as recited in claim 8, further comprising the step of maintaining a pressure between 1 and 80 millitorr during the etching and stripping steps.

10. The method, as recited in claim 9, further comprising the step of maintaining the substrate at a temperature between 10° and 100° C during the etching and stripping steps.

11. The method, as recited in claim 10, wherein the step of electrostatically attracting the plasma from the etchant gas comprises the step of biasing a chuck supporting the substrate to a bias power between -10 and -1,000 volts, and wherein the step of electrostatically attracting the plasma from the etch mask stripping gas comprises the step of biasing the chuck supporting the substrate to a bias power between -10 and -1,000 volts.

12. The method, as recited in claim 4, further comprising the step of maintaining a pressure between 1 and 80 millitorr during the etching and stripping steps.

13. The method, as recited in claim 12, further comprising the step of maintaining the substrate at a temperature between 10° and 100° C during the etching and stripping steps.

14. The method, as recited in claim 13, wherein the step of electrostatically attracting the plasma from the etchant gas comprises the step of biasing a chuck supporting the substrate to a bias power between -10 and -1,000 volts and wherein the step of electrostatically attracting the plasma from the etch mask stripping gas comprises the step of biasing the chuck supporting the substrate to a bias power between -10 and -1,000 volts.

15. A method for etching at least partially through a metal-containing layer disposed above a substrate, wherein part of said metal-containing layer is disposed below an etch mask and part of said metal-containing layer is not disposed below the etch mask, comprising the steps of:

placing the substrate in the etch chamber;

etching away parts of the metal-containing layer not disposed below the etch mask, wherein some of the etched away parts of the metal-containing layer is redeposited to form residual sidewall passivation on the substrate, while the substrate is in the etch chamber;

stripping away the etch mask and removing some sidewall passivation while the substrate is in the etch chamber; and

removing the substrate from the etch chamber.

16. An apparatus for etching at least partially through a metal-containing layer disposed above a substrate, wherein part of said metal-containing layer is disposed below an etch mask and part of said metal-containing layer is not disposed below the etch mask, comprising:

means for placing the substrate in an etch chamber;

means for flowing an etchant gas into the etch chamber;

means for creating a plasma from the etchant gas in the etch chamber;

means for etching away parts of the metal-containing layer not disposed below the etch mask, wherein some of the etched away parts of the metal-containing layer are redeposited to form residual sidewall passivation while the substrate is in the etch chamber;

means for discontinuing the flow of the etchant gas into the etch chamber;

means for flowing an etch mask stripping gas into the etch chamber;

means for creating a plasma from the etch mask stripping gas in the etch chamber;

means for stripping away the etch mask and removing some residual sidewall passivation, while the substrate is in the etch chamber; and

means for removing the substrate from the etch chamber.

17. (New) The method, as recited in claim 1, wherein the stripping away comprises removing parts of the metal-containing layer that are redeposited to form residual sidewall passivation.

18. (New) The method, as recited in claim 1, wherein the stripping away comprises accelerating oxygen plasma to the substrate to remove parts of the metal-containing layer that are redeposited to form residual sidewall passivation.